7.6 LITHIUM-THE IMPORTANT RESOURCE OF GREEN TECHNOLOGY: PROPERTIES, GEOLOGY AND TURKEY'S POTENTIAL

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ABSTRACT

Lithium has become one of the indispensable elements of modern industry due to its unique properties, such as its lightness (ρ = 0.53 g/cm3 at 20 oC), high specific heat capacity, the lowest ionic radius among alkali metals, and high electrochemical potential. The Action Plan on Critical Raw Materials of European Commission published in September 2020 predicted that the demand for lithium will increase 50 times in the next 2050. For this reason, the exploration of lithium deposits in the earth's crust has become very important. This study reveals the lithium's properties, geology and Turkey's lithium potential.

According to the United States Geological Survey (USGS), the world's total lithium reserve is 98 million tons, and the world's total lithium production in 2022 is 130,000 tons. The lithium resources occur in three different geological environments. These are (1): Pegmatites, (2): Sediment-hosted deposits and (3): Brines. The world's current lithium production is produced from three resources: brines (64%), pegmatites (29%) and clays (7%). The lepidolite minerals in magmatic rocks, clay sediments in boron deposits, current and dried lake basins (Tuz Lake, Acıgöl, Lake Van) and geothermal waters constitute the most important lithium resources in Turkey.

KEYWORDS: Lithium, Properties, Geology, Turkey's Potential

INTRODUCTION

Lithium is the alkali metal with the lowest density (ρ = 0.53 g/cm3 at 20 oC), high specific heat capacity, low ionic diameter and high electrochemical potential among the alkali metals (Garrett, 2004; Christmann et al., 2015). Due to its physical and chemical properties, lithium and its compounds are used in a wide variety of industrial applications such as ceramics, lubricants, aerospace, polymers, metal additives and especially Li-ion batteries (Dessemond

et al., 2019; Zhao et al., 2023).

Lithium is widely distributed in the earth's crust and is found in rocks, soil, salt lakes, seawater, oil reservoirs, geothermal waters and many natural waters (Wietelmann and Bauer, 2000; Helvacı et al., 2006;). Lithium occurs in three types of geological environments. These are (1): Pegmatite deposits, (2): Clays and (3): Brines. The brine deposits constitute 66% of global lithium reserves.

The EU aims to be climate-neutral by 2050 – an economy with net-zero greenhouse gas emissions. It is estimated that annual electric vehicle sales will increase to 10 million in 2025 and 28 million in 2030, and electric vehicles will constitute more than half of all passenger vehicle sales in 2040 due to net-zero greenhouse gas emissions. These developments in electric vehicle sales are

expected to increase global demand for lithium (EU 2020). For this reason, the exploration of lithium deposits in the earth's crust has become very important. This study aims to reveal the properties of lithium, its geological formations and Turkey's lithium potential.

RESULTS and DISCUSSION

Properties

Lithium is the metal with the lowest density, coming after hydrogen and helium in the periodic table. Its atomic number is 3, and its atomic weight is 6.941. The name lithium comes from the Greek word "lithos" meaning "stone", represented by the symbol Li. Lithium is a soft, silver-white metal in the alkaline element group. Like all alkaline elements, Li is highly reactive and flammable. Therefore, it never occurs freely in nature and only occurs in compounds, usually ionic compounds (Vikström et al., 2013).

There are approximately 130 known lithium minerals. The silicates, phosphates or borates are mostly lithium carriers, except for 14 minerals in the carbonate or fluoride group (e.g., griseite [LiF], zabuyelite [LiCO3], cryolithionite [Na3Li3Al2F12]) (Christmann et al., 2015).

Lithium Deposits

Economical lithium deposits occur in three different geological environments. These; (1): Pegmatites, (2): Clays and (3): Brines (Christmann et al., 2015; Bowel et al., 2020). There are three different types of brines as continental (lacustrine), geothermal and petroleum.

Lithium resources in brines 66% of global lithium reserves are in saltwater reservoirs. There are three different types of brine reservoirs: continental (lake), geothermal and petroleum. There are studies on lithium production from pegmatites, clays and brines in the world. The lithium production from brines is the least costly and least laborious of the known methods. The method includes precipitation, purification, ion exchange and absorption processes.

Turkey’s Lithium Potential

The lepidolite minerals in magmatic rocks, clay sediments in boron deposits, current and dried lake basins (Tuz Lake, Acıgöl, Lake Van) and geothermal waters are the most important lithium resources in Turkey (Akgök and Şahiner, 2017; Gülez et al., 2019).

One of the main resources of lithium is granitic pegmatites. Petalite in these rocks is another important lithium source. Potential sources are acidic rocks containing lithium-rich mica, such as lepidolite and tin granites (Gülez et al., 2019). The presence of lithium was found in the aplites and pegmatites of the granitoids located between Kırşehir-Yozgat-Akdağ Madeni (Kadirioğlu, 2002), in the pegmatites of the Menderes Massif in Çine (Aydın) district, and in the migmatites of the Menderes Massif in the Manisa (Gördes-Demirci) region (Selim, 1967).

Clays in boron deposits contain high amounts of lithium. It is located in the octahedral layer of the clay mineral of the lithium hectorite type. High lithium values were obtained throughout the boron deposits in Turkey (Bigadiç (0.02-0.21%) and Kırka (0.16-0.30%) clays). It is closely related to minerals in which lithium sodium element is found in high amounts in boron deposits (Mordoğan et al., 1995). Lithium values of 1256 - 3,009 ppm were found in the Kırka (Eskişehir) boron deposit,

25 - 982 ppm in Emet (Kütahya), 254 - 770 ppm in Mustafakemal Paşa (Bursa), and 152 - 2,709 ppm in Bigadiç (Balıkesir) (Gülez et al., 2019).

Lithium values in salt water are quite high. Lithium values between 20 and 365 ppm were found in Salt Lake. Lithium values up to 100 ppm have been measured in Konya-Karapınar Meke and Acı lakes. A lithium value of 29 - 48.5 ppm was found in Kayseri Sarıoğlan Tuzla lake. Values of 270 ppm were obtained in Tersakan Lake and 50 ppm in Bolluk (Gülez et al., 2019).

The geothermal resources in Turkey contain high amounts of easily soluble minerals and metals due to the geological characteristics of the environment. Lithium concentration reaches a maximum of 68ppm in geothermal resources in Turkey. Lithium is produced from geothermal fluids that reach the earth through drilling to take lithium's heat in geothermal resources. The geothermal fluid, from which heat energy is extracted and the lithium it contains, is pumped back into the reservoir with a closed system. Therefore, in the lithium production facility to be established in enterprises operating on the use of geothermal fluid, the transportation of the fluid to the lithium enrichment facility and the process of pumping it back to the reservoir will not impose an extra cost burden on the enterprises (Yıldız et al., 2021).

CONCLUSIONS

This study aims to reveal the properties of lithium, its geological formations and Turkey's lithium potential. Lithium is the metal with the lowest density, coming after hydrogen and helium in the periodic table. Its atomic number is 3, and its atomic weight is 6.941. There are approximately 130 known lithium minerals. Economical lithium deposits occur in three different geological environments. These; (1): Pegmatites, (2): Clays and (3): Brines (Christmann et al., 2015; Bowel et al., 2020). There are three different types of brines: continental (lacustrine), geothermal and petroleum. The lepidolite minerals in magmatic rocks, clay sediments in boron deposits, current and dried lake basins (Tuz Lake, Acıgöl, Lake Van) and geothermal waters are Turkey's most important lithium resources. It is very important to explore in detail these geological environments containing lithium in the future and to conduct technological tests on lithium extraction from these resources.

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